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J. R. Bowring.

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UNIVERSITY OF ALBERTA

FACULTY OF ARTS AND SCIENCE

(Department of Political Economy)

A THESIS

SOME ECONOMICS OF SOIL CONSERVATION

Submitted in partial fulfilment

of

requirements for the degree of

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(Master's program: five graduate courses
in addition to this thesis)

by

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PART I.

4. Settlement.

With the rapid increase of settlers to the northern districts, in the nineteenth and early twentieth centuries, the town thought has followed developments. In years gone by the pioneers were content with a modest home meeting the necessities of their ultimate necessity to inconceivable heights, the natural result of the enormous rise in a realization of their hopes. Here upon site of this enormous land stretched as far as the eye could see, and little wonder the emphasis lay on speedy exploitation.

The advance was first confined to the Eastern shores by an extensive belt of dense bush bordering the Atlantic. This settlement formed therefore a type of stability. Gradually, the surging hordes of European peoples pushed beyond the Eastern fringe. Forests were cleared and farmlands sprung up where before only natural vegetation. The factories and the first towns were erected first by hands, then by machines turning the pioneers of a new nation. The grandeur of its ever unfolding power enthralling both the nationals, and very soon the nations around were roused.

From then on encouragement by Government and other institutions paved the way for immigration, and the agricultural wealth of the land became a reality. Settlement has not ceased in great waves, and the tempered ardour of the first flushes and dreams, gave to this hardy nation a

social revolution of their choice, in the face of local scarcity brought by water which could have journeyed at last over the spines of the highest social eternity, little wonder this settlement was so rapid. In retrospect, with the knowledge which we now possess, it is little wonder that the pride of ownership became an object in itself. It would not be safe to assume that the potentialities of the land which they settled could have been found by any united other than trial. However, such contemplation took second place when compared with possible land ownership. The pressure of a great hue then built which could not have continued to hold the ugly claws for unregulated settlement much any of may not have been later rejected.

Looking back it is apparent that a mistake were broken which should have never seen the plough. Before a struggle was started, erosion through was vegetation destroyed. Wild animals were slaughtered wholesale for their meat or their pelts as many men gloried in the wealth of untrammelled nature.

Such a settlement never before equalled for speed in the history of the world not continue unchecked. Soon the scarcity of virgin land began when the plough was used as and productivity settled at a generally lower level. The erosion is practically now for a time, followed by new inventions and labour saving machinery. Agricultural methods were evolved, and high prices for agricultural products brought new, unthought

the breaking of wide areas of sod land. Wide open miles of flat bunch prairie lay exposed to the winter. Much of the protection afforded by trees had gone along with the binding protection of natural grass covering. The wind blew and drying up the surface soil carried it along on its course. Drifts followed and in many parts where stubble was scattered, bare patches of subsoil were soon visible. Where it occurred, the loss of this top soil was the loss of the most vital part of soil for agricultural enterprise. Once it leaves a field it can be replaced as lost, because it cannot be located from accessibility. Fifty soil is reproduced from its parent material at such a slow rate that a field which has lost it can safely be regarded as impoverished at least for many years.

In some parts classes of water deposits caused gullying, and sloping fields were soon cut up into deep ridges. Insufficient allowance for retention caused great loss of valuable rainfall. The natural consequence of this physical displacement was reduced returns for heavy labour. Hardship and humiliation threatens were the outcome. Particularly in the United States where settlement is more dense, and in Canada people are awakening to the fact that all is not as it should be, that the land which they settled has changed. Settler faults became apparent, but in many cases the troubles can not be ascribed to individual action. Thus under such conditions have people begun to realize some of the meanings of the word conservation.

II. [illegible]

The difficulties arising out of agricultural settlement and land [illegible] are not new. They date back to the days of the earliest civilizations where man tilled the soil for a living. It will be interesting, then, in our study of present day problems to glance back at the history of some of these early settlements, and in so doing form a background for the discussions to follow.

[illegible]

In Mesopotamia there were extensive deposits of the valleys of the rivers. The sediment brought down by the rivers Tigris and Euphrates was deposited on the alluvial plains, or delta as the Persians call it. The Babylonians settled on the fertile land, and the protection against inundations built many miles of levees dykes. Irrigation operations are by this time extending further north between Bagdad and Samarah. As the level of the Euphrates was higher than that of the Tigris south of Bagdad, the area between was honeycombed with irrigation canals. In spite of [illegible] the latter, these canals filled in with the sediment and the waters of the rivers escaped into the Tigris [illegible]. Thousands [illegible] were and dams were built to control a continuous flow of water. Civilization reached a high level. However, constant struggle between Babylonia and Assyria for political supremacy resulted in abandonment of cultivated lands. Canals were destroyed by invading armies and the surrounding lands were a desert. Such

storms have led to violence and war & more extensive.

The [illegible] of agricultural products has brought on by [illegible] to [illegible] of a growing [illegible] flow. The [illegible] flow of waters was intercepted with mud [illegible] which was once conducted [illegible], houses. With the presence of [illegible] and a decline in the available [illegible] labor, the [illegible] has greatly proved increasingly difficult. Fields became deserts and the wind blew [illegible] where once was a flourishing settlement. Today the country of Babylon and Assyria presents only [illegible] the ruins surrounded by [illegible] and [illegible] tribes [illegible] at [illegible] battle between [illegible] and [illegible].

[illegible]—Food and Dress

The Bible brings us stories of the [illegible] Hebrews and their settlement in the Promised Land of Canaan. There they [illegible] the agricultural practices of their predecessors. A fertile [illegible] and vegetation of [illegible] prevailed. The [illegible] were reserved for kings and the [illegible] of forest and [illegible] were forbidden by law. Sheep and goats were pastured on the hills and were a serious factor in preventing the regeneration of the forests.

The seasons were dry and hot [illegible] and cool [illegible] during the winter months. Storms were frequent and in the hills were [illegible] of their natural vegetation. [illegible] were frequent.

re-

(1) H. H. Bennett...oil conserv tion. p..8.

led by the tributaries of the Orontes River was destroyed by man and many such ill-gotten gains have been done to restore this fertility.

The Greeks were originally a pastoral people. The valleys were forested and the valleys were fertile. Similar conditions exist today on some of the smaller islands of the Aegean Sea. With the growth of population, towns, farms and homes were needed, the frontiers were extended, forests were cleared. That the land situation was a problem is shown by the formulation of the first Greek tenure laws by Lycurgus of Sparta. Colonies were established, but shipping many were dependent by war and placed the state in serious international problems and led to deterioration of land. This was noted by Xenophon in the fifth century B.C. who made a profit from restoring worn out farms and resettling them.(1)

The muddy rivers deposited large amounts of soil at their mouths. Topsoil from the mountain slopes was washed and was carried down by the rivers to the sea. Grazing was practiced for the protection of the timber lands but little thought seems have been given to control erosion. Today a number of these sloping lands still remain, and in certain lands have been saved by present conservation policies of modern Greek agriculture.

(1) Loc. cit. ... p. 48.

ITALY

According to Greek records, the cultivation of land in Italy was introduced by a Lydian colony by the Tyrrhenian Sea. Hybrias had been driven from the Lydian city of Sardis by famine and pestilence. The Greek colonists found only the Iberians, destroying the irrigation works and leaving the flood embankments. All the rivers overflowed their banks and the marshes and the higher lands were of necessity cultivated. This encouraged erosion and flood hazards with complete abandonment of the more productive areas.

With the decline of conquering barbaric tribes deforested the mountains and the cultivated land on the higher slopes increased the amount of erosion. Virgil describes the conditions of his time, "The swift rivers, flood from the mountain streams overwhelm the fields, sing down the sinking woods, flocks and the work of the oxen, and sweep the forest with a terrible crash".(1)

In the Italian peninsula, a more settled agriculture was built up. The farms were small and land was cultivated involving by the landowner and his family with perhaps a few slaves. Erosion was recognized and measures of prevention carried on. Good farming was regarded as the highest of accomplishments.

(1) Virgil... Aeneid. Chapter I., p. 508.

[illegible] were [illegible] [illegible]
[illegible] and combined [illegible] the [illegible] of the [illegible]
[illegible] were introduced to take part in a system of rotation.
[illegible], a [illegible] was [illegible] by the [illegible] was used
to add nitrogen and humus to the soil thus restoring certain elements.
Virgil tells of a rotation used on [illegible], grain and legumes.

The period of empire building led to a decline in domestic agriculture. [illegible] grain from North Africa and Egypt was imported, and in the second century B.C. the distribution of free grain was introduced. This system existed for many years, and in the time of Julius Caesar 320,000 people in Rome were receiving free grain. This encouraged larger holdings and the raising of cattle in preference to grain. Olives and vines were introduced 200 B.C. and an intensive cultivation of land followed. Some writers state that at the beginning of the Christian era, it was a widely accepted belief that the land of Italy had worn out. Under the prevailing climatic conditions the period of decline which followed, however, served as a fallow period during which the land regained some of its native fertility. It would seem then, that while all the necessary and more which the Romans exercised in their pursuit of agriculture, [illegible] of land and a decline in political importance came about.

With the fall of the Roman Empire [illegible] declined in the Italian Mediterranean countries, and it was the eleventh

century before a renaissance of agriculture once more in Europe.

PERSIA

A similar story can be told of the rise and fall of the Persian Empire. Under Cyrus, the unbroken tribes of Persia were united. Agriculture flourished and the population increased. Irrigation was the only form of cultivation possible in central Persia and Turkestan. Increased cultivation raised the height of floods and the rivers burst to seek their courses. Old fields were abandoned and new ones cleared. Dust storms occurred on the loosened abandoned soil, and in places the level of the land was lowered five or fifteen feet by wind erosion. About the 11th century A.D. the reception revealed widespread deforestation and salinization, with a consequent decline in the area of land and the economic ruin of the country.

INDIA

The long narrow field system introduced by the Romans and continued until the eighteenth century existed in a shortened form of the earlier wooden ploughs. Steep hills were terraced and the natural water supply was relied on for tillage. The concern by reason of its extensive food resources took a great interest in problems of agriculture. It included the experiences of earlier civilizations in the Mediterranean into use and with them methods of relative conservation. In the

and on the seventeenth century French influence introduced many new ideas as a result of increasing contact. Both these of these rebellions in the Scottish rebellions, economic [illegible], rentors, heavy and clavers. [illegible] Lowland, Arthur Young, and Sir John Sinclair played outstanding leaders in the establishment of a stable agriculture with the adoption of sound agricultural, emphasis which had [illegible] basis for soil conservation.

In Scotland the limited amount of level land may have been responsible for [illegible] of conservation regarding [illegible] practices than in England. Deforestation in large areas of the highlands dates must be the blame [illegible] with the extreme [illegible] from [illegible] Scotland and England about 1750. Severe [illegible] intensive farming. Plant cover destroyed and more the ground was left bare [illegible] on dry surface soil were blown away by high winds. According to Fenton [illegible] in Scotland since farming, both directly and indirectly has altered the appearance of a large part of Scotland".(2)

With our brief glance at the [illegible] other countries it is remarked that the problems of [illegible] are continuous. At no time are they entirely solved and [illegible]

(2) Fenton, E. Hyams...The Influence of Man on the Vegetation of Some Grazings in Scotland. Journal Ecology. Vol. 8 No, pp. 644 - 650. 1937.

settlement of new lands has become more difficult. The advancement of agriculture has been made possible by the introduction of methods from older areas. It seems that such developments pass through a stage of readjustment to new conditions present a potential erosion hazard or hazards where the fertility of the soil may be decreased. It is natural to expect that the problem is not known or realized at the beginning of settlement. The individual settling on new land in new surroundings is generally in no position to deal with his own setbacks have proved themselves faulty. Study of these adjustable problems may give a lengthy and perhaps futile 'trial and error' method of investigation.

Canada and the United States present examples of this transfer of agricultural ideas to new surroundings. The various settlers brought with them methods and practices common to the country of their origin, and possibly highly successful under those conditions. It is inevitable that both a process of readjustment should involve enormous errors of judgment and misfortune ensue. It is a question of science, by its accumulation or just knowledge and experience, to shorten this period of adjustment.

There has been a tendency in the past for research in agricultural economics to lay emphasis on individual farm problems and the prices of farm products. Recent depressed conditions in agriculture in the Western Hemisphere have brought to light new sets of problems which cannot be handled adequately by the usual research procedure. The breadth of the problems lies in the field of land use and live stock systems, the forces that determine them and their effect on natural resources.

It would be well at this point then to introduce the nature of the soil conservation problem. For the purpose of discussion, let us consider soil deterioration under the headings, erosion and fertility depletion. That the two may be synonymous we will acknowledge, but when referred to in the later discussion this distinction will be followed.

(a) Erosion can be considered as a qualitative loss, or a loss of the basic material which has developed through time by weathering or deposition. Professor J. S. Bonsor has referred to this resource as being a 'fund' resource. Thus when we see the top soil removed from a field by wind erosion we can say that field has suffered a 'fund' loss.

(b) Fertility depletion on the other hand we will regard as the loss of chemical nutrients and biological forms from the soil which may be termed a qualitative loss. Professor Bonsor has referred to these resources as 'flow' resources, implying that they can be renewed annually, and that their loss and replacement tend to be a continual process. For example, the idea of potassium from

a soil by crop growth can be termed a loss of 'fertility' resources.

From these definitions then, it can be seen that both forms of soil deterioration are closely related. Erosion losses however tend to be more permanent and require more drastic restoration than fertility depletion through crop removal.

[illegible].

A. Normal Erosion - All soils in their natural environment are subject to a natural erosion. It is a normal geological process contributing to the known variations in the earth's surface. This erosion aids in the formation of soils and proceeds at a rate equal to the pace at which new soil is formed. Under the normal influence of vegetation, micro-organisms, climate and chemical activities, the soil has an almost balanced run-off removal. Plant food elements are removed in solution as a result of leaching under the internal circulation of water. Leaves and twigs fall and through decay are returned to the soil. Soil layers are formed [illegible] while growth proceeds at a slow rate.

B. Wind Erosion - With the removal of the protective vegetation covering [illegible] soil, its rate of erosion is greatly increased. Without control it can become one of the most acute factors in deterioration of fertility. Wind erosion has caused some damage in Western Canada.

Wind erosion may take the form of a slight disturbance of the soil surface or may at the [illegible] storm velocities

in dust storms sweeping across large tracts of land. Since loss of wind erosion and disturbance of the surface may take place in any dry area agricultural problems are created. In the brown region of the province, removal of the natural vegetation is apt to accelerate the wind erosion process to a great extent. During periods of little rainfall, removal of the organic matter provided by vegetative growth hurts the soil serious blow to any possible subsistence. Fine loose material is particularly susceptible to being swept along by the prevailing winds. The rate of disintegration into the powdery dust material on the soil type in question, size of the particles and organic matter present. The sorting of the very fine particles is comparable to a sifting process. A strong wind can have come to carry the more fertile powder boundreds of miles leaving behind the coarser and less fertile material.

These rainfall and dust particularly low in the period 1930-1937 in the Canadian Prairies, the role of removal by wind developed at three into dust storms. The lighter the particles the further they were carried and the heavier materials were piled against fences and ditches and other cover. Under similar conditions in the Eastern United States, a sheet of soil was reported to have deposited uniformly at the rate of five tons per square mile of every form. In Europe the amount of material that fall in Switzerland during the dust storm of 1928 is reported at

field have for sweep time.[1]

Wind erosion may proceed in any direction and is not influenced to any great extent by the slope of the land. Its damage can be considerable not only to the land from which the soil originated, but also to shelterbelts and land in its path. Hills in blow roads and engulf a which may prove harmful in the case of which they are transformed.

Where such erosion is not serious crops may still be grown. It must be evident, however, that land in the serious soil must reduce the fertility of that land. Without consideration of the practicalness of treating land in any area, it would appear logical, if it is desirable to reduce the land to a condition approaching its original state, that some form of prevention of soil drifting is necessary.

c. Water Erosion - Water erosion is the transposition of soil over exposed land surfaces by rolling storm precipitation. The slope of the land, the soil type and the method of cultivation followed will affect the rate of erosion to varying degrees. Sloping areas are susceptible to sheet erosion, where a loose shallow surface soil overlies a heavy subsoil. This form of water erosion generally proceeds at a slow rate and its existence may not be observed before considerable damage has been done. A change of soil texture with the exposure of subsoil as bedrock may

(1) F. L. Duley...The Movement of Soil Material by the Wind. U.S.A. Department of Agriculture. Bureau of Soils Bulletin 68. 1911.

often to the first indication that the surface has been slowly washed away. Other forms of water erosion are surface scaling, a less visible form of sheet erosion, rill erosion and gully erosion. The latter occurs where the run-off has a more gathering velocity to yet see ridges or gullies in the land. In friable soils, when allowed to continue undetected, the flow through the gullies will gain progressive movement to leave permanent scars.

On sandy soils, run-off picks up and carries away the lighter particles by a process of selection, leaving behind the heavier particles. Even here may be an actual backward change from a heavy to a lighter soil. Such things are seen in Scotland when stones from deposits the coarser particles on the progress. There is an light on the side of the soil particle that can be moved by [illegible] and uncontrolled water results may cause damage both immediate and others so.

Forms of Erosion Control.-

Soil with a permanent covering of vegetation is in the ideal condition to ensure stability and prevent erosion. Before the settlement of any erosion by the roots and the natural covering which existed [illegible] to control erosion fail. Therefore, although [illegible] can prove to control under the present agricultural economy of the country, any form of erosion control which is published [illegible]

the possibilities of erosion. These methods will of necessity vary with the prevailing types under cultivation. The value of a vegetative covering in the prevention of erosion can only be realized when the effect of the rain on the soil is understood. In the first place, the direct impact of the rain on the soil is evident, thus preventing clogging of the soil crystals. Secondly, run-off is checked reducing the speed of the water and its ability to pick up soil particles. At the same time the organic matter of the soil is increased improving the water holding capacity of the soil and encouraging infiltration of water.

In the control of wind erosion strip cropping has been accepted as one of the most effective methods. [illegible] In general the strips are placed at right angles to the direction of the prevailing winds. Thereby the velocity is retarded, and the area of bared soil exposed at one time is reduced. In parts of Western Canada cultural methods of trash and fallow are used with great success. Other forms of control which are practised generally when the soil begins to move, are tillage operations which improve the surface by tilling or plowing up of the sub-surface.

On sandy and shallow soils these methods can only be regarded as temporary measures as long as the organic content of the soil remains low. In fact on all soils the permanency of the tillage methods as effective forms of control of wind erosion

cannot yet well be be finally established.

There other remedies against the formation of gullies, the best method of prevention and control is by providing a permanent cover, duly occupied, against cultivation or water diversion to prevent the concentration of water in any one place. Contour strip cropping is conducted on the lines across the slope instead of up and down the hill, in this way preventing the rapid of water downhill.

Permanent control involves :-

(1) Water conservation by catch-drain diversion, and spreading structures, and contour cultivation of fields, and contour furrowing of crops land to provide contously of vegetation cover.

(2) The use of protective vegetation shelts and hedges of grass, crops, shrubs or trees.

(3) The adaptation of crops and cultural practices to existing topographic, soil, moisture and seasonal conditions.

(4) The conservative utilization of increased supply resources produced by those measures.

(5) The retirement of critically eroding areas to permanent vegetative protection.

(6) A multi-land extensive mode may involve between types of livestock operation and farming diversified farming plus the growing of supplemental feed crops only.

(7) The proper distribution, stabilization and development of grazing

on range lands, and adjustment of numbers to carrying capacity."(1)

Besides the use of cultural methods of erosion control the growth of certain plants or a good stand of trees maintained in the proper locations will also give adequate protection. Where feasible a permanent pasture is the most satisfactory growth for erosion control, but the use of soil building crops in rotations or as cover crops is also of great value.

Fertility depletion.

Fertility depletion as we understand it can be hardly considered the complex problem on the particular land in question. Under natural conditions the growth of any vegetation would imply a loss of soil constituents. The cycle is completed by the return of the plant through decay to the soil from the surface. When the crop is carried away as in the growth of wheat by man this cycle is interrupted. By taking away the plant and its included mineral and nitrogen elements contained in the soil, obviously, the soil has suffered fertility depletion.

The permanency of these losses depends on the later treatment of the soil. Thus the application of chemical fertilizers, manure or certain beneficial crops plowed under to return to the soil an equivalent of the constituents taken away. The definition would not necessarily imply that exact replacement

(1) H. H. Bennett...Soil Conservation. p.738.

of the leaves is removed but prior their appearance.

The history of agriculture as far as it is known points to a fertile soil as one which has continued in this for the reaches of long periods of previous vegetation, and that it has been infertile as the result is cultivation. The rate at this deterioration and the extent are matters which depend on a great many variables.

In Rothamsted, England, experiments on the growth of wheat for fifty years in succession on the same land attempted to solve the problem of reduced fertility. A comparison was made of manured and unmanured land under continuous crops.

"There can be no doubt that the produce of the unmanured plot has gradually declined; and, independently of the evidence of diminishing produce, analyses of the soil at different periods show that there has been a gradual diminution in the amount of nitrogen in it. But owing to the great fluctuations in the amount of produce from year to year in addition to manure, it is by no means easy to establish the decline due to exhaustion of the soil, as distinguished from variations due to the seasons."(1) Further "It remains to be seen what will be the result in the future, and whether a point has already been, or will in time be reached, at which the produce will remain constant, according as it is determined by the fluctuations of the seasons."(2)

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(1) Sir Joseph Henry Gilbert...Agricultural Investigations at Rothamsted. Six lectures delivered under the auspices of the London Agricultural Society. p. 147.

(2) Ibid. p. 148.

Dr. Gilbert further states - "It was been seen that the manured plot was declined in yield and fertility, but there can be no doubt that the farmyard manure plot has on the other hand increased in fertility. Analyses of the various soils at different periods have shown that it has become richer and richer in nitrogen as that of the unmanured plot."(3)

Besides the use of manure, the growth of legume provides a supply of nitrogen to the soil and maintains the fertility of the soil. "A certain piece of ground [illegible] was divided in 1873 into two plots, one of which was planted with clover, the other barley. In the following year [illegible] was grown on both plots." Results of this experiment are as follows:

	Plot where clover was grown	Plot where barley was grown.
Nitrogen in crop (1873) lb. per acre	151.3 (in clover)	87.3 (in barley)
Nitrogen left in soil after crop was removed (1873), per cent	0.157	0.1
Nitrogen in crop (1874) lb. per acre	83.4 (in barley)	80.1 (in barley)

A chemical analysis of the value of certain crops and their effects on the constituents of the soil, is not the concern of this treatise. It may be safely stated however, that the principle use of crops is retaining the fertility of the soil [illegible] be maintained and increased if necessary.

(1) Sir John Henry Gilbert...loc. cit. p. 149.

Under current cropping practices, the rate of fertility depletion is slow, and there is no great [illegible] problem. Where needs are related to [illegible] and crop [illegible] with the crops, the determination will be somewhat.

"How little the wheat plant is able to survive when in competition with weeds, may be seen from a portion of the Brindabella field where the work here is still allowed to stand and shed its seed, but is not being cultivated in any way. In the following season, a fair wheat yield came up and gave wheat half a crop, but after it seeded the weeds [illegible] that land upon the ground until in the fourth season only ten or twelve stunted wheat plants could be found."(1)

The [illegible] of Sir Joseph Banks Norton on the alleged [illegible] of the [illegible] is interesting.

"Whereto the land has, as a rule, only been skimmed, practically no labour bestowed on cleaning, and compared with the produce which such lands should yield if properly cultivated very small crops of grain have been obtained. But the large crops occasionally grown under the [illegible] are evidence of the inherent fertility, and of the possible productiveness of the soil.....However...the land is worth is grown under the conditions present and intend, almost inevitable, in the more

(1) A.J.Ewart...The Flora of the Tablelands Experiments upon wheat.

of new material, with normal cultivation - that is, growing it for several years in succession, with sufficient cultivation, destruction of weeds, the hoeing of the crop, and generally the mulching of the nature of the working stock - only low yields can be expected. The practice generally results from the fact that under such conditions fertility is very low indeed.[1]

History has shown that because of the importance of cereals to human food they were grown continuously as long as the land would yield remunerative crops. Then the usual device of growing the crop a few (usually) years in succession, then of leaving the land in bare fallow, or ploughing to weeds and so-called green manuring of the country. The farmer realised the value of legumes grown in rotation with cereals. The growing of herbs as an alternate crop was introduced in England by Lord Townshend in 1730 in the famous Norfolk rotation of turnips, barley, clover and wheat. The value of such rotations in the maintenance of soil fertility as expressed by crop production, is now accepted by agriculturalists everywhere.

Soil fertility we have set that as crop-yielding value can be registered to a great extent by accepted practices of direct application of soil nutrients. But the level of soil fertility can be established within reasonable limits of climatic variation,

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(1) Sir Joseph Henry Gilbert...principal investigations established. His researches carried out under the provision of the Lawes Agricultural Trust. p. 171.

brings us to the question of the individual farmer. His knowledge or lack of knowledge of the cause of declining fertility and his application of this knowledge to his land will tend to reflect itself in the fertility of the land in relation to a point of time. Many years of cropping practices which deplete the soil without compensating measures to maintain its fertility, and lack of control over weed growth can be said to be contributing factors to fertility depletion.

PART III.

IV. [illegible]

[illegible]

Conservation of soil is the maintenance of the productivity of that soil. That soil productivity will vary under different conditions of climate and environmental relationships, implies that its level for maintenance must vary accordingly. Conservation itself is a variable subject according to the level of productivity to be conserved.

The condition of the soil in its natural state is no criterion for the level of productivity to be conserved. This is to be viewed as just as the human element plays into the relationship. A level of fertility may be above or below the level of virgin fertility, depending on soil treatment. By the use of fertilizers, irrigation or improved techniques, soil fertility may be raised considerably. On the other hand under certain conditions of production, the fertility of a soil may be lower than the original virgin soil cover was broken. In this definition of conservation, the natural level is to be conserved when one takes into consideration, but rather is it implied that at a certain level of production be it high or low, conservation is the maintenance of that level.

[illegible]

Exploitation must be considered in its relationship with conservation. It is relative to the extent that we are

[illegible] a level of maturation. A country at this level could fully exploitation, but not until such level is attained can exploitation be said to exist. However, assuming a certain level of production is below of this level, any decrease in productivity by fertility depletion or erosion can be considered as exploitation.

[illegible]

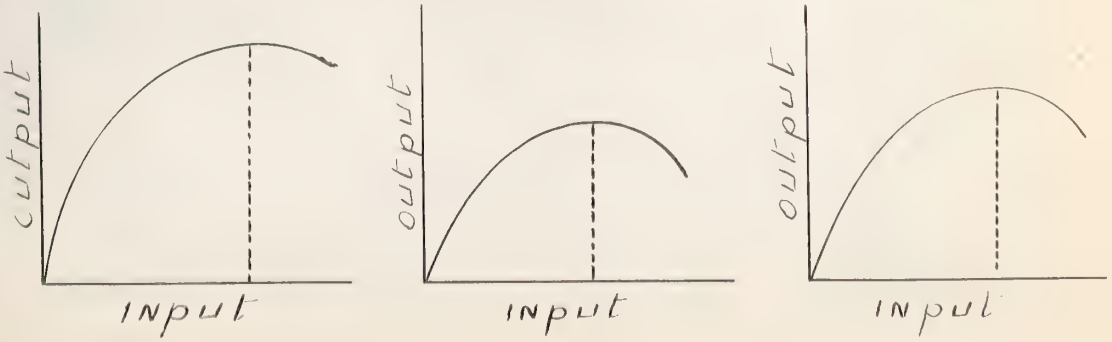
As exploitation is associated with a decrease in productivity as reclamation is associated with an increase in productivity. Where reclamation is practiced, the level of fertility is raised toward a higher level than the one originally existing.

To explain further, let us define fertility of a certain piece of land as the capacity of this land to produce. This productivity which we will term output is dependent on three main factors - (a) [illegible] (b) [illegible] (c) the input.

A. Land
A. Product

B. Land
A. Product

A. Land
B. Product



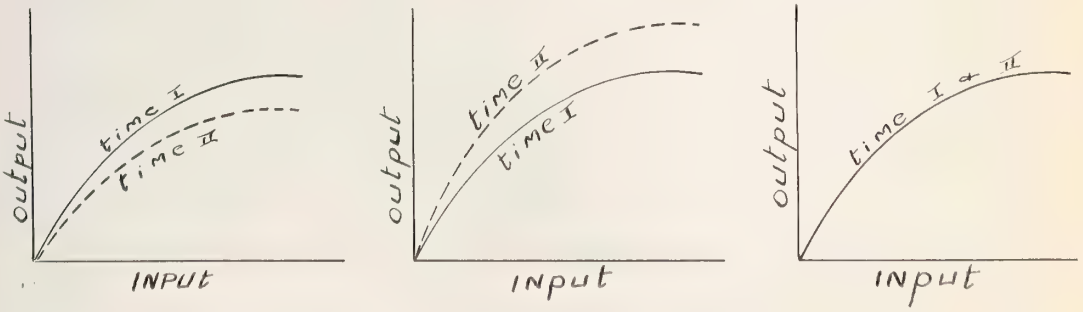
Using this terminology [redacted] conservation, exploitation, and reclamation can be said to exist under the following conditions:

(1) Conservation - The maintenance of soil fertility by (a) the same input, (b) the same crop; (c) the same output.

(2) Exploitation - A reduction in fertility by (a) the same input; (b) the same crop, (c) reduced output. Over a short period of time the following conditions may exist: (i) the same input; (ii) the same crop; (iii) the same output; but if continued would result in (a), (b) and (c).

(3) Reclamation - An increase in fertility by: (a) the same input, (b) the same crop; (c) increased output.

Exploitation	Reclamation	Conservation
A. Land	A. Land	A. Land
A. Product	A. Product	A. Product



——————— Productivity at one Point of Time

- - - - - - - - Productivity one Unit of Time Later.

V. [illegible]

Erosion

With the previous understanding of erosion, it is to be assumed either that the continued lowering of the soil actually or soil removal by wind or water has reached the stage where permanent cultivation have to be resorted. It may be said then, that if conservation is introduced at any point where erosion has occurred, the level of fertility is not as high as when fertility depletion may existed. From this it is not to be assumed, however, that it was also to be observed at any point of time previous the one in question. Generally prices and prices of the products over the years may have been such that conditions was under the same conditions may more profitably even when natural depletion of the soil was occurring.

Let us take the point of view of an individual landowner. If a farm or woodlot were being used at less than the optimum level would its owner respond to high possibility in the future. It would seem to be a selling of capital stock for present satisfactions. However, any decision to change the form of production followed in the past with the object of conservation would involve several considerations.

First of all, it is to be assumed that the adoption of conservation measure will involve expenditure. Resources before were employed and the value would be evaluated

to value the capital loss and the loss is not in any way covered by a consideration of the present worth of production. The capital cost concept of depreciation of erosion and the possible effect of any changes on the way farm income would have to be charged with the productive assets, if the present system were continued.

The calculation of capital loss would entail certain simple estimations. The following is an example of the type of method which might be used to arrive at this capital loss.

If sheet erosion were gradually carrying away the top soil, the farmer's first step would be to estimate the rate at which it was being carried away. This could be effected by comparison with the depth of top soil on existing, neighbouring uneroded land. Having estimated a rate of erosion time by measuring the depth of the top soil remaining on his own land he could calculate the number of years required to remove it all. Then by comparing the value of his land at prevailing prices with the probable value of the same without a top soil, the difference would indicate total capital loss. The annual rate of depletion would then give him the annual capital loss. Estimating the value of his land without the top soil (his future profit depends on the type of subsoil remaining.

Having estimated the annual capital loss, the next step would be to estimate at the costs incurred in conservation at the present level of farming. These costs would vary with

topography, degree of rainfall, the soil type and the area used. The capital outlay necessary for the particular situation together with expected annual costs, could then be ascertained. By comparing two schemes of prevention and cure, the farmer is now in a position to judge whether it would be profitable for him to invest in conservation measures in the retention of his capital, the land.

To this must be added consideration of an annual sacrifice he should face as land is eroded continued. If erosion were allowed to continue unchecked, then a decision to conserve certainly at a later stage may involve greater costs because of greater capital charges.

The attitude of the farmer to his land must influence any investment in conservation. Suppose that the annual loss in yields and capital just equalled the annual cost for control. This would be the point from where the saving of conservation would be measured. An investment in costs over the saving and expected returns under conservation would show that it was uneconomic from the individuals point of view. Alternatively an investment in saving and returns over the most annual cost that conservation was possible. The farmer may consider it more profitable for his purposes to allow the erosion to continue unchecked for a number of years, bared on the calculation of annual

[illegible] would be [illegible]. It will be discussed later the conditions of land ownership may limit [illegible] interests in the land in question. The returns from the land may be so low under the present method of farming [illegible] interest in conserving that level is lacking.

These considerations, however, are [illegible] the individual farmer. It may be [illegible] because of damage to neighbouring lands or streams, whether a [illegible] could best be initiated [illegible] the benefit of society before the time it would be most profitable for the individual. Therefore where it could be shown that such measures were profitable for the individual at that particular time, the government may be prepared to pay the additional costs or [illegible] the expenditure on the individual. Such clashes between the interest of the individual and those of society do occur will be discussed later.

If conservation practices are to be followed, an attempt should be made to bring the aspects and the [illegible] involved in the [illegible] to readily [illegible]. Only then can conservation be encouraged amongst [illegible] farmers, especially where alternative and attractive [illegible] may [illegible] pressure for [illegible] action.

Terminal Remarks

Further [illegible] on the assumptions we have made of the difference [illegible] problem, is more difficult to measure. A continued cropping tends to reduce the plant nutrients and

organic matter from the soil. Humidity may be encouraged and fertility increased with disturbance of the soluble nutrients. Some of these losses, however, is irreplaceable. Use of fertilizers, like the changed cropping system may be continued to restore the soil fertility to its original level.

Such applications, however, are long-run investments. Assuming that after a period of cropping the soil fertility had been restored to such a level that additional capital expenditures are no longer needed to prevent erosion; then to the capital and labour costs must be added the loss of valuable crop(s) time. Such a gradual method of farming would not be conducive to a stability of production over a long period of time. To this we will add that a slower rate of progression is undesirable as not a desirable feature.

The gains the yields from the soil during the period of cropping would be accompanied with deforestation improvements and a certain amount of the soil erosion have maintained the volume of production. This might either be reflected in higher prices of the goods produced or if such prices is fixed there may be losses, a reduction from this form of receipts.

It would seem logical then that between the harvesting of the first crop and the enforced cessation from cropping because of erosion, there is a point of time when a desirable level for conservation is reached. The difficulty lies in

determining at each point of time conservation becomes possible. If it is said that it is economic to maintain the level of fertility at the point where the marginal product just pays for the marginal inputs of labour and capital we must accept a theory dependent on many variables.

This level of productivity under conditions of free competition will vary with the price of the goods produced and the costs of labour and capital required to maintain this level. These prices will in turn be determined by the demand both in the domestic market and if exported, the world market for the goods in question. If such a theory were accepted, then high prices and low labour costs, might have the effect of using both fertility depletion and erosion economic. This might also apply where high labour costs and high prices occurred on virgin land where productivity was high. Such a condition existed on the fertile Egyptian during the Arab Rule. With such a relation of prices, costs, there may have been a tendency for that type of production to reach the stage where marginal cost = price would still be gained for the goods with little time to labour costs would lower returns. It is by such time the costs of the situation making it more difficult, and hence conservation, would have progressively increased. The products would not pay for the inputs of labour and capital necessary for continued

production. However, further production under these price conditions would be uneconomic. If, however, production were continued the added costs might have to be borne by society in the form of relief or some other emergency contribution.

From the long time point of view, the original input-output theory of economic conservation may not be the best when the physical welfare of the land is considered. Instead a closer correlation with the fertility of the soil and less with price would bear investigation.

It is here that the "Breaking Point" of Natural Fertility Theory as expounded by Edmund Schenkel might be discovered.(1) Considering the soil from the physical output point of view, the levels of fertility of different soils vary. Each soil has a characteristic fertility which we will term "natural soil fertility". This refers "to the natural load of currently available plant nutrients and other chemical, physical, and biological conditions in the soil".(2)

If, assuming constant climatic conditions a given piece of land suitable for wheat production is put into wheat of the same variety year after year, then the wheat yields represent a measure of the fertility of that soil. Starting with virgin soil the yields will remain constant for some years.

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(1) Economics of Agricultural Land Use Adjustments. Iowa State College. Bulletin 209. p.305.

(2) Ibid. p.305.

Thus the decrease in available soil nutrients, and more erosion will be sufficient to cause a gradual decline in the yields. The rate of decline will increase until such time as the crop residues and decomposition of soil material will again be kept through erosion and loss of plant nutrients. From that point on the decline will slow down and the yields may then find a stabilized level. The point of yield where the rate of decline begins to increase substantially may be referred to as the "breaking point of natural fertility".

Such a condition has been pictured with a uniform outlay of capital and labour. No account has been taken of technical improvements. During this period more efficient plant and cultivators, or improved sowers may have been brought into use. Also the results of agricultural research and education may have spread together with more intensive cultivation. Instead of decreasing, yields may have remained constant with an appreciable lift from continued cropping. Decrease in natural fertility and technological improvements have occurred simultaneously. Thus the decline in fertility cannot be measured by crop yields under normal conditions. The "breaking point" of natural fertility does not necessarily coincide with the time when yields start to decline.

If such a thing were possible then, the public could be told the point of time when the fertility "breaks". This

this would be difficult from the individual point of view because of the social pressure of the condition that one have equal physical growth and mobility started at the same time. Consequently under the same condition male type A would be found on the extremes of a continuous line of variations and hermaphroditism would be found in the middle of the range. The end of the process theoretically may not be in the lifetime of one. From the short time point of view, however, we must accept the present concept of male sterility and its tendency to increase under continuous single stimuli.

For practical purposes, it would be desirable for society and the individual as a long time production basis to apply conservation practices before or at the "knowing point" of male sterility. In this case yields would not only have to be kept the equivalent of hermaphroditism, but would remain reasonably constant under normal conditions.

Thus we see that the point of time at which it is considered profitable to conserve is desirable. This would apply both to conditions of complete male fertility depletion. Under the original case theory it might be profitable to continue cropping at the same rate after fertility depletion had occurred, by means of the application of chemical fertilizers and improved hybrids. This process might be continued even after erosion had started. However, these applications would

[illegible] the [illegible] [illegible] [illegible]

V. [illegible]

In newly settled countries such as Western Canada, it is to be expected that some time must elapse before land true agricultural land values can be realized. The process of these adjustments may be lengthy. More important, the true value of agricultural land is based on the annual net crops and its ability to produce such crops. Other factors such as location and transportation facilities are considerations of this certain type. Therefore, the main factors influencing farm land value is soil fertility.

When the first assessment of this land occurred its value may have been based on the short time yields from the land following breaking. The result would be, if the estimated fertility were low, an overvaluation of this land, during later periods of production. Such a case may have the social and economic repercussions. It may have been the cause for the overvaluation of land in Western Alberta, this overvaluation being accompanied by a considerable lowering of assessed values from year to year in certain areas. Of course, it may be stated conversely, that it can also be based on original productivity would be a cause for undervaluation of certain lands also.

The point in question is this - present certain virgin land has been broken and production of crops commenced. A value is placed on this land either from a very few or a short time

point of view. This value is based primarily on the ability of the land to produce crops. Apart from this ability to produce, the rules and social structures such as schools and communities are built, the upkeep of which becomes dependent on the type of agricultural production from the land. If no conservation of the soil is practiced in the type of land management or otherwise, then it is safe to assume that eventually yields will decline. This yield decrease will be later reflected in lower returns to this area. Each inland costs is calculated but most of the original land values cannot now be reinstated. A difficult period follows and government subsidies may be necessary in such areas.

On the other hand, suppose that after the original breaking, the native crop adapted by the lowers of conservation fertility of a certain type which would tend to raise physical crop returns were at least constant for the area. Land values are then based on their physical productive which gives a satisfactory path to the farmers and the landscape. A balance social and tax structures are built around these values.

Now the maintenance of this level of production is not a natural function, but artificial manipulations of various kinds. Besides agricultural chemicals a decrease in crop returns by the introduction of suitable cultivation systems may be necessary. The beneficial crops grown may have a lower cash return value. Further, costs may be raised by the introduction of suitable drainage systems to water conservation. Whereas whatever crop

ure, can be regarded as a decrease in net yield in the time. Thus, it may be seen that the original land values are not taken into account when added cost. Instead of stabilizing the economy, it becomes increasingly difficult to meet up the social standard set in the upward values. In other words, there is no indice set for the systems to counter-act instability. In a free society, a working out process will evolve. The land values can be adjusted to increase with added cost or the returns under the system raised to meet the prices. If no such action is taken, it may be found that the conservation practices followed will fail into disuse. Continued instability depletion may lead to erosion until a stage is finally reached when either the land is deserted or government help comes as a necessity.

VII. [illegible]

Social Background

Land distribution must of necessity be closely associated with the economic needs of the day. Early cultivators in Europe saw no need for concerted or planned efforts in the production of crops. This was influenced both by the needs of the cultivators and the crops which they grew at their disposal. Any areas of heavy soils and forest might have encouraged true cultivation until later improvements, such as the iron plow, made their use possible.

Increase in population meant an intensification of use on the lands in question. Greater labor was expended, improvements in cultivation practices were effected and yields increased. The loss of sufficient goods also affected the more extensive expansion into new lands. The cost for new cultivation in relation to possible returns was high. The areas of land severed, which had grown up by this time had placed large areas in the hands of a few. This labor entered into what is known as the feudal system. The land surrounding the settlements formed the 'demesne', which was used for live stock grazing and was an integral part of the village economy. As cultivation became more intensified on surrounding land, previous pasture was increasingly reduced and the use of the 'demesne' as

pasture became more indispensable than ever. Breaking new land for cultivation was thus curtailed.

Under the influence of Roman laws, the land outside the demesne was not public property, but belonged to the king, a custom which lasted for many centuries. Thus an institutional scarcity of land became apparent. During this period, land was regarded as the only tangible wealth, and it was granted as rewards for public service or distinctive work. This was originally for the lifetime of the recipient, but it eventually became hereditary, and the land became a permanent possession of a particular family or Church. 'Free' land disappeared. In its place a yearly payment for the use of land was to be obtained from the feudal lord. At the same time 'Tolls' or 'Duties' had to be paid on land for which permission to use had been obtained. These land charges tended to check the expansion of agricultural production. As a result the land then in use was farmed more intensively.

Forests were conserved for hunting purposes, and here too any phase of agricultural production generally forbidden, as interfering with the rights of the leaders, the more costly investments.

This condition of land ownership later gave way to the Manorial System. The serfs exchanged use of their land

by tenants, who served him on a family basis. Villeins were formal and servants life existed. An annual payment was made to the landlord, in the form of rent, and their money was arranged accordingly. A permanency of association between a piece of land and a certain man's family was built up. This is interesting from the point of view of soil conservation, because as the tenure came to regard the land as his own, he treated it accordingly. This permanency is the keynote.

The landlord protected his interests by a supervision of the customs previous followed, which of cultivation, and the forbidding or cutting timber without special permission. Manorial courts were in force to punish offenders of the rules laid down. If these rules were followed the landlord-tenant relationship generally evolved into an agreement satisfactory to both parties. The annual payment by the tenant was generally a fixed sum. Therefore, the greater the care and treatment of the land, the greater would be his personal revenue over and above the rent payable. The result was that the tenants gained an economic security which led to greater care in their land use practices.

The growth of cities and the poor transportation facilities existing paved to even more intensive use of

[illegible] and everything the cities. Conservation [illegible] of rabbits and nature applications, were followed so that protection could be maintained. Thus, were cities in Europe at the end of the 18th century. It will be noted that conservational practices had evolved not as the last as an object, but because of institutional and social factors.

With the beginning of the 20th century land rehabilitation and conservation problems were the subject of a great deal of writing and investigation. Some of the land was no longer needed as the result of machine development, but was being appreciated as an end in itself. The breakdown of the old marginal units, and the 'transfer' of the workers led to the abandonment [illegible] larger tracts of land [illegible]. With high prices for products because of war, there was a tendency to produce for production sake, without due care of the soil. In [illegible] particularly, the disappearance of the forest has led to a great deterioration and careless use of the woodlands.

This phase of agricultural history passed, however, and under the new order conservation became extensively practiced, and an acknowledged essential for successful farming.

Land Ownership.

For the purpose of soil conservation many writers tend to regard ownership of land as an end in itself. That a man owns a farm they say, he regards it as an investment, and will thus ensure his utmost care and attention. His thoughts for the future and his family will never then be with more great confidence of present satisfaction for the future of his descendants. Little will be spared by him on the way of labour, and whatever capital he possesses he will, and to use the buildings in good condition. Further, it has often been said that lack of interest in conservation of farm land in the past was due in great part to the non-ownership of land.

Some of these statements may be quite true. However, it would be a mistake to assume that land ownership was a major solution to the conservation problem. It is to be expected to some degree, that a man has a greater interest in his own property than property belonging to someone else. It may be his aim to build up a permanently productive farm, but because of capital and economic barriers he is often unable to make the necessary investments. Soil conservation methods often sacrifice at the present for the future. It may be, however, that any further delay on the part of the owner would mean a socially undesirable lowering of standard and perhaps loss of title.

A great deal must also depend on the type of owner. An owner desiring to sell may abuse the soil in an endeavour to improve a return higher with the cropping potentialities of the farm. An owner of very poor means may be too busy to exercise the fullest control over the use of the land or he may not have interest in the land beyond his own lifetime. These are the factors to prove that land ownership in itself is not a sufficient basis for the introduction of conservation practices. Though there will be variation in the attitudes of the owner, it is safe to assume, however, that a land owner with an interest in the fertility of the land beyond his own immediate satisfactions will be interested in methods for conserving that fertility.

Tenure.

There are several types of land tenure in force at the present time. These are on an owned basis rental basis, or some basis or a combination of the two. In Western Canada the share crop basis is the most common, while in other more established countries the cash rent basis is found to a great extent. There are other forms of tenure in practice, but it is not our intention here to study the tenure system. The main point in question is the effect of ownership or non-ownership of land on the conservation of

tant land.

Sufficient information correlating cultural practices and land tenure is not available in Canada, although attempts have been made to correlate the two in the United States. Reading and arguments on certain assumptions then, seem appear to be the main factors relating conservation and land tenure.

(a) The length of the lease.

(b) Landlord-tenant relations.

(a) In areas where agriculture generally is prevalent there would appear grounds for expecting a certain stability between productive and conservation factors. However, in areas where tenancy is the main type of land occupancy, the stability would seem to vary proportionally to the length of the lease each person has with them. In farms where short time agreements exists, such as one year, it is not to be expected that the operator will have as great a concern for the future condition of the land as a tenant on a long term lease agreement. Many of the erosion problems will of course depend a great deal on the degree of control the landlord has over these practices. Suppose a landlord has definite plans for conservation of his land, then where the agreement entails full control by this landlord of the

type and acreage of crops sown, whether all the land should be used, the length of lease will have little effect on conservation. On the other hand, if the tenant is under no control by the landlord as far as cropping practices are concerned, he may have little or no interest in soil conservation. The tenant may attempt to extract from the land all he can in the shortest time at the lowest cost. This can be modified by the particular tenant, the cultural practices common to that area and the nature of the crops grown. Such a condition may not exist at all. However, we must admit that under a yearly lease agreement, and this year to account year's property, there would be a tendency to attempt immediate needs with a minimum amount of sacrifice for the future of that land.

In cases where the lease is of longer duration, the effect on conservation may be different. The tenant is then to have stock and plan for the length of the lease. Assuming that the tenant has free choice in the matter of enterprises, he is desirous of obtaining the maximum returns for the period of his occupancy. Thus he attempts this and he may be forced into some methods of conservation so that these returns will be yield. The restrictions and duties on the part of a renewal of the lease will also

[illegible] effect his attitude to the land. Where the lease is to be definitely terminated, the latter part of his occupancy may tend to an exploitation of the soil resources with present satisfaction his only interest. Where the possibilities of renewing the lease are favourable, however, he would tend to conserve for the whole period if they were almost his own. The practices followed may be expected to vary between the two extremes of length of lease.

(b) The relation between the landlord and the tenant will have its effect on the care of the land. If they have family ties, their term would tend to be a closer understanding as to land use, and the safety of fertility. A cash relation is probably the poorest system to ensure-maintain this fertility. On the other hand, relations between landlord and tenant may be socially abstract, and any interference on the part of the former resented, unless embodied in the lease agreement. The nature of the land fertility may be of less importance to the echelon of this branch than is necessary for security-time. He may even go out of his way to take from the soil all he can in the shortest time possible, depending on the length of the lease. Here again, between these two extremes will be found individual cases. Part time landlord tenant relations may have any effect on soil conservation is of importance.

[illegible] one or more sets of the variables which affect the relationship between tenancy and land conservation. Broad generalizations are impossible, although tendencies may be identified. Each case must be treated separately on its own merits, depending on the condition of tenure, the landlord and the tenant himself.

In certain parts of Navajo social development brought a condition of greater stability and understanding between the landlord and the tenant. The tenant was often brought up to regard the land as his mother [illegible]. The land became a part of his life and its protection and care an accepted feature of his position. This attitude has been encouraged in no small way by legislative protection. Compensation for improvements by the tenant should be leave the land and the binding nature of leases all tend towards his regarding the land as his own. Conservation is encouraged because of the knowledge that what he and the land will be used by his children or he will receive compensation for the efforts should he leave. In order was the landlord. The Navajo tenant cannot be expected to take the measures of conservation without some inducement to do so. This inducement may be in the form of greater tenure security, or a monetary reason for effort expended. Any family relation-

ship between conservation and hunting on this continent may be in part due to this lack of legislative protection for the hunter. When a hunter only receives a share of the duty, it is natural that he will try to maximize his returns, rather than the success of the hunt. A resulting relationship between the hunter and the target often paves the way for a sharing of the costs entailed in conservation and help to develop a common objective for the two. Frequent changes of tenant will develop a transitory management responsibility which is not in keeping with stable fertility.

VIII [illegible]

The amenities necessary for any form of conservation are limited by present needs, social views of posterity and the length of time before renewable or conservable are likely to mature.

There is a similarity between investment and conservation. In fact conservation can be said to be a form of investment. Therefore, there are many considerations from the point of view of the individual before he starts conservation practices, that will be very comparable with any individual considering other forms of investment.

Conservation usually involves the postponement of present income and satisfactions. This would imply a certain restraint in spending for immediate satisfactions. For the individual then, whose present needs are satisfied and there are no other urgent needs for immediate satisfaction, a wise investment of surplus income would be a natural procedure. There are many conditions under which he would consider such an investment, however. In the first place a normal security must be assured that the investment will once returns available for the amenities necessary. If this were not the case, under free competition, the suitable investor would lose elsewhere for more profitable channels. It may be said that future rewards

are the only reason for the accepted present consumption, a consumption which in very few cases is not capable, and satisfactory. Individual time preference places a limit on how much would be effective by investment. The greater the risk involved the greater would have to be the return expected and the less the incentive to invest at all.

In a normal investment in natural resources, the investment would be subject to continue some time before returns were available. Therefore, a compound interest rate based on these continuous payments would be more in keeping, than a single interest rate, in any computation of returns. Following this approach then, the final returns on investment should equal the accumulated continuous rent plus compound interest on the original investment. At lower returns, incentive for investment would be lacking. It is realized at this point that the application of this theory to soil conservation would be difficult both in the calculation of costs and the computation of returns.

There are several modifying factors to be taken into account. The first of these is the present needs of the individual. It is true at this point that not until present needs are more nearly met will the surplus income be considered for investment. However, the needs must vary

with individuals and communities. Great variations would be expected between different nationalities and levels of society. If present needs themselves are not satisfied then possible investments will gain little attention from the people involved. It can be safely said that where the incentive is very strong for greater saving, the economic needs of a group or individuals must be satisfied before conservation or investment will be considered by them.

Then again, there are good and bad investments, and the capacity of the individual or any other body to differentiate between the two will affect the results. Under normal conditions, a proportion of bad investments is inevitable. A bad investment is considered as one unprofitable both to the individual and society.

It is natural to expect that, that the chance of time before returns from investment, are uncertain, may be limited. There an individual only is concerned this will be the case, and the time would be limited to his expectancy of life. On the other hand in the case of a corporation or a family the period may tend to definite limitations. A farmer with a family under secure conditions of ownership, may be quite satisfied if the returns from his present expenditure will be gained by his descendants. Nevertheless

less, there may be limitations on the time he can assume are available, which will affect investment. In the case where a definite time limit is set, it would be more nearly to measure the value of the corporation as against the optimal values invested. For example, a farmer intends to invest in conservation measures. Due to circumstances, results of the conservation must be available within a period of time, say ten years. Then there would be possibilities of existing with some degree of accuracy, the cash of the outlay and returns to be expected in ten years time.

The attitude of various individuals in the culture of society must vary. A person may have an interest in things beneficial for others than himself, and investment may not interest him. His outlook may be that of expending all the available income at his disposal for his immediate satisfactions. His outlook on goods may be that they have complementary to his needs, so that there would be no consideration of a purpose for possible investment.

While the effects of such an outlook are limited to the firm in question, any problems which may arise are for the individual to solve. On the other hand if the practices pursued by this farmer seem foreign to neighboring land on conformance to his neighbors, then collective coherence may be deemed advisable.

"more borrowings are necessary for expenditure
[illegible] the greater is, then the interest rate payable
on these borrowings will affect the mob. With a high
interest rate the mob would be greater than if a low in-
terest rate. On the other hand, if borrowings were not nec-
essary, and the prevailing interest rate on alternative
investments were high, then liquidity preference with
more favorable relative right rates are attractive than in-
vestment in the soil.

Then again, if the prevailing interest rates on
borrowings and alternative investments were low, in-
vestment in the soil may prove more attractive.

With a fall in the prevailing interest rate in
other investments, the desire to withhold the soil so that
the greater returns would be available for these invest-
ments would be lessened.

Whether the farmer is insulated or not insulated
from investments other than in his farm, must have a bear-
ing on any determination of marginal use of investment.
If alternative investments are available, then the tendency
to invest in fixed assets in these alternatives may be
greater than the tendency to invest in the land. The rel-
ative returns will consequently be an important factor,
so that the amount to invest in factory may be greater

or less dependent on the individual.

A farmer's interest in conservation may be increased by the availability of borrowings. A re-activated or a municipal credit mobilization allowing low interest-rate for conservation purposes would do much to bring conservation investment within the realm of possibility for the individual.

One discussion of conservation as an investment that could not be argued back to conservation might be an account presented with the interest rate on capital borrowed that may be fairly attainable. In any free choice, expenditures made on the conviction that they be eventually repaid by the individual with the promise of some future reward.

A. [illegible]

Consideration of certain actions and their effect on the individual must also be considered in their broader effect on society. Just as the individual must bear costs to obtain benefits, so must society, ideally it is of the divisible, bear social costs. The fact that these costs are sometimes difficult to measure in terms of dollars and cents does not detract from their importance nor imply that they should be neglected. Actions which appear economic from an individual's point of view may, through lack of foresight or ignorance, be uneconomic from the point of view of society. The individual's primary interest is for or loss to accrue, in the sole, personal cash economy, and the ultimate effect of such costs on his own sphere of endeavour. Thus there may be some actions of a society who unknowingly or knowingly benefit society by their actions to a greater degree than they themselves are benefitted. In some cases, society might be called upon to help bear the costs of these actions. By any action, cannot however, that an individual cannot take such action as are to greater values for others than for himself.

There are cases where benefits are donated to society which we cannot object since even the well-being

of society. Further investigation might prove, however, that social standing, assets or custom were involved and that the returns to the donor in satisfaction were equal to the donations. Under present conditions, it is fairly safe to assume that the individual will attempt to transfer as large a proportion of his costs to the other person, as is possible. There is no thought of disservice involved, but merely the logic customs prevailing. From a social viewpoint, the use made of the agents of production and the transfer of costs are important in the protection of one individual against another. A knowledge of such costs is their origin so that their members may know their duty is a function of a non-organic society, such as is recognized today.

The future of a society is wrapped up in its customs. In a society which is primarily agricultural, the methods of land use are its particular concern. The use or misuse is of vital importance to the future growth of that society. Therefore, the individual actions of farmers must be examined both in regards as the society as it exists at that time and also as far as possible, to the future of that society. Farmers should ignore the society of which they are a part, but the single reason that they

themselves are first noticed. Only by the legal protection evolved by themselves and their fellow members are their property rights respected and are they allowed to maximise their operations. Since there the outline of cultivated features may be of preliminary concern to society rather (a) Continuous change of the land. But the cultivator in his seeking all the costs of his decisions may or may not be apparent. If, however, the landlord's control is completed by overstepping on the part of the tenant to satisfy his present needs, as the tenure extends to neighbouring lands then such governments would feel justified in combating any such damage.

(b) The same views evolve in the case of the various kind of behaviour which is neither profitable to the cultivator nor society.

(c) If harvesting is essential before market conversion practices can be economic, then the interest rate or lack of available capital may be the cause of a backward behaviour.

(d) The price of products is such that conservation at the prevailing level of fertility is uneconomic for the individual. So we may see more difficulty arising in the relationship of individuals and society in the available use pressures of costs involved.

As far as investment in conservation is concerned many writers are of the opinion that the government is better able to evaluate present and future costs and values than is the individual. They base their arguments on the opinion that the foresight and knowledge of the individual is of necessity limited to one or more generations. Society on the other hand as represented by the government is possessed of all the knowledge available from its members. They are able to see the effects of certain actions with greater accuracy because of their greater knowledge of the interesting forces within the system. The government does not tend to think in terms of one or two generations, but rather in many generations through time. Any actions are considered in their effect on the whole rather than in their individual results.

From this reasoning may be evolved the existence of "social time preference". Dr. Ramsey argues that individual and collective time preferences or foresights are not the same.(1) He says "Why should many societies whose standards of social value emphasize the authoritybed existence of generations within a distinctive social scale deny the foresight of the individuals reach over several generations. On the other hand, there are social goods which because of their very nature can be supplied only if a continuity of their

(1) Journal of Pol. Economics...Economic Aspects of Land Conservation. Vol.41.1933. p.477.

supply, independent of the foresight of individuals, is guaranteed. These goods are, for example, religious and cultural development, education, public health, and the perpetuation of the entity of the group."

Fertility depletion where the damage is out of a lasting nature is the concern of the individual. However, where misuse takes the form of soil erosion which will have permanent effects on the fertility of that land, then society must of necessity show a greater interest. The problems of the future become their primary concern.

A farmer's rate of conservation or investment are influenced by the interest rate and his individual time preference. This time preference relates to his evaluation of present and future utilities in relation to the interest rate prevailing. These future utilities appear in the form of savings, so that if the time preference is greater than the interest rate the individual will borrow, and if less he will save. It is an opinion of the individual on the merits and demerits of saving as compared with present satisfactions and as such a subject, is related to the interest rate.

The opinion is held that, that since society has the possibility of spreading risks over the whole population,

there is a tendency towards lower interest rates for the government than for the individual. This is causing high interest rate to be accepted as a measure of the future value of savings. The individual on the other hand is influenced by the prevailing interest rate, his own personal time preference, and expected future returns for himself. His time preference is of necessity more limited to his own particular sphere of activities than "social time preference". It will vary with conditions of upbringing, nationality and foresight. If, as Dr. Ruttan states the interests of society are wider than those of the individual then "society might very well be justified in investing efforts for the conservation of land under conditions where interest rate and expected future returns would make it impossible for individuals to do so." (1) That is to say, although the government should take into account interest rate and other social costs in the consideration of land conservation, these costs should not affect their actions to the extent that they would affect the actions of the individual. "In other words social costs ..... should not and should not always determine social actions in the field of land conservation." (2) However, continues Dr. Ruttan it is

(1) Loc. cit...p.472.
(2) Ibid...,.473.

essential but these taxing governments could not thoroughly explore the social costs involved before making such decisions.

Thus the concept has been put forward but "social time preference" is of greater importance in the consideration of publicly investment than the individual time preference. While accepted by many it has been opposed by others.

J. F. Dewey challenges the accepted idea that the government should bear the cost of conserving soils because society has a more reliable time preference. He raises two objections on three reasons:

"(1) there is no basis for it in currently accepted economic doctrine.

(2) it leads to serious maladjustments and chooses the real causes of misconduct objectionable of resources.

(3) since issues are clouded it happens more difficult to devise the type of social or governmental action best suited to remedying any particular situation."(1)

The problem of "social time preference" makes it difficult to compare with individual time preference because no measures of value have been evolved. Mr. Dewey disagrees with the use of the concept of time preference at all, as being too abstract, in the sense society is concerned. There

(1) J.D.Dewey...Time Preference and Conservation. J.F.E. Vol.XXII-5. p.534.

are too many disturbing factors in the life of a society to consider its future as an interval rate basis. There are too many unpredictable and unquantifiable elements which would interfere with the "equalization over time". To assume that society should have a greater knowledge of the future than the individual is dangerous because of the general uncertainty of the future.

Even accepting the theory and ensuing economic behavior, the individual's time preference can have little influence on the actions of a producer. If the individual's time preference is less than the interest rate then he will maximize his returns and save, if his time preference is greater than the capital rate or interest he will maximize his returns and borrow. Obviously there can be only one effect of maximizing his returns and that is dependent upon the most prior expenditure (assuming the interest rate) and future expenditures.[1] Therefore, the time preference theory would seem to be of relatively more from the general principles resulting in costs of conservation and value of capital preserved. The general argument is that the time preference theory is irrelevant for application to conservation theory. Its greatest fault lies in its abstract nature and its unreliability, where costs, expenditures and returns could and should be obtained on the formation of

(1) Loc. Cit., p.388.

economic problems as to whether or not welfare.

However, from both schools of thought a unified form may be obtained which will make the most profitable theory applicable to conservation planning. There is good reason to believe also that the actions of individuals over time may evolve into actions which are most advantageous both for the individuals and for society as a whole.

2. [illegible]?

In accordance with our previous arguments we can assume that under certain conditions the individual can be relied on to conserve soil fertility. This would be the case where the benefits to be gained by conservation accrue to the farmer, and are apparent as returns for present sacrifice. In other words, if it will pay a farmer to conserve his soil, there is a distinct possibility that he will do so. Thus both society and the individual are served.

The situation may be, however, that although the farmer realizing what advantages he may gain by certain actions, is unable to change his present methods. Methods of conservation generally require some adjustment, and it may be that the farmer is not able to acquire the means for this outlay. Knowing the present fertility of the soil and his personal needs and limitations, he may not feel that further borrowing would be a wise move on his part. If conservation practices had been adopted when he first homesteaded he might have paid for them out of current income. However, continued delay and perhaps unwise investments may have placed the now increased cost of reclamation and conservation, at a much higher level.

The governing body of a society would be interested in each case if the continued fertility of the land were of importance to it. The individual realizes and acknowledges the fact that his present actions are not conducive to profitable farming now or in the future, yet he is helpless to remedy the situation. Therefore, the government would have sufficient justification in assisting the individual. Such assistance might be in the form of adequate developmental capital, through a system of credit. This credit available at low interest, or perhaps no interest, would be the means whereby the individual farmer could bring his land back to a profitable state of production. Improvements would coincide with the return of fertility.

Before such assistance were given, however, it would be necessary for the government to ensure that the proposed investment in this land would not be more profitable in some other direction. The situation might arise where a farmer continued to crop his land only if a grant were made. The land could be brought back into a condition suitable for the type of agriculture previously practised. Even a complete change in land use might be considered more advisable. Faced with the particular conditions, the government and the individual might agree on a course of action for the ultimate benefit of both.

There a farmer is interested in the retainment of the fertility of his soil, then with the knowledge and means at his disposal he will adopt conservation practices. Alternately there may be the case where a farmer is knowingly depleting his land for his immediate satisfaction. The fact that he is permanently damaging the land with no concern for the future use of that land creates a fine point as to whether the government would be justified in interfering with such practices. The legal rights of the government in this direction must vary with different legislation. However, this such action would seem justifiable from the standpoint of the welfare of agricultural land in a country, there conservation.

A government may have encouraged the settlement of new land, and with full knowledge of the limitations of the settlers abilities, invested a certain land use. Individual capital is thus invested on the advice of this government. If this land use proved unsuitable, then society should take part of the responsibility for aid in correcting and adjusting this use to an economic one. The individual should not be under the compulsion, however, that total responsibility for readjustment lies with the government.

Where the use of an operator's land interferes with the economic use of neighbouring land, then the government

must take the responsibility for correction. If this were not so, the farming practices of one operator might have considerable effect on the results from other land in the area.

Part of the program of any government should be to see that the individual is aware of the advantages to be gained from economic conservation. At the same time they should inform him as to the limits of the individual rights in so far as land use is concerned. Particularly is this so when the effects of his use interfere with the use of land other than his own. As stated previously, these rights will vary with countries and local legislations, but whatever they may be it is the responsibility of the government to enforce its legal rights in the use of the land.

PART V.

VI. [illegible]

The settlement of Western Canada is interesting among other reasons because of its relative speed. Such a rapid settlement as occurred on strange land, and under strange conditions must be followed by a period of adjustment. This may be a lengthy or a short period depending in part on the pertinacity settlers and the skills which were developed for their use.

Occupied and Improved Land in the Provinces Territory of Manitoba, Saskatchewan and Alberta. (1)

Year	Occupied Land (acres)	Improved Land (acres)	Improved Land Per Capita
1881	1,926,000	772,000	4
1891	8,138,000	1,423,000	6
1901	15,512,000	5,503,000	13
1911	57,512,000	23,970,000	17
1921	87,051,000	44,631,000	23
1931	99,372,000	49,131,000	24
1936	120,776,000	53,304,000	24

From this table will be seen the rapid growth of settlement as indicated by occupied land. Within the period of forty years, 1881-1921, 52,872,000 acres of land were improved, or an average of 1,321,800 acres per year. The growth of improved land per capita was from 4 in 1881 to 23 in 1921. Considering the available machinery it would appear that most of the land in question required little labour or

(1) W. A. Mackintosh...Prairie Settlement. Vol.I.

its initial improvement. Between the wars, and part of this period saw the rapid return into the steadily prairies more turning the soil was the primary move to cultivation.

"Neither Ontario nor provincial governments is but they had sufficient information based on scientific soil and meteorological surveys to ,convey any form a long-time plan of agriculture."(1)

That a reaction from such hasty ones we should occur seems natural. The part played by humidity in the pre-ground,weed suffering, pests and insects were a part of this reaction. The settlers themselves were of a many types, using as they did from all parts of both the New and the Old World. They brought with them systems of agriculture in which they had been reared under totally different conditions. Systems which were suitable for soils in Europe could not be expected to suit unconditionally the soils of the Prairies. Settlers from the United St tes brought with them systems based on their earlier experiences in the Mid West. Settlers from Europe brought with them systems of Russia, the Ukraine, Germany, France, Belgium, Ireland and Scotland. Many were with no farming experience at all.

The settlement of the Western Provinces can be

(1) R. H. Archibald...C.S.T.A. Review. 1924.

said to have been a period of experiment, and of trial and error, for which time is the main antidote.

Settlement first swept across the Red River over the dark brown prairie soils. The wooded country was preferred to the dry belt which exists in the north in an area known as "Palliser's Triangle". However, after 1900, inroads were made on this "Triangle" by farmers. Rail-line policy and the need for roads(1914-18) influenced the new rapid growth of cultivated acreage in the dry areas. The period 1911-21 of falling prices and poor crops saw some abandonment of areas west of the cultivable belts and mixed region. Increase in settlement still continued in the Park and forest belts and some less arid parts of the prairies. Nineteen hundred and twenty-six to nineteen hundred and thirty-one saw an increased settlement in the Peace River area. Over 1/2 of all land under 1st entry in the prairie region were vacant or abandoned in 1926 [1] and readjustment is still continuing as to size of farm and suitability of use.

Railways were extended through the area. In 1870 the first railway reached Winnipeg, connecting the Red River Settlement with St. Paul and Chicago. Subsidiary lines grew, and in 1902 the Canadian Pacific Railway completed its line

(1) Agriculture, Climate and Population of the Prairie Provinces. Dominion Bureau of Statistics.

through to British Columbia. In 1907 an agreement was reached between the Dominion Government and the Grand Trunk Railway for the construction of a trans-continental line. The Eastern section, from Moncton, New Brunswick, to Winnipeg, and the Western section from Winnipeg to Prince Rupert. From them on branch lines and branch lines extended to all settled points on the Prairies. The rolling countries, encouraged settlement and the Canada Colonization Company under the control of the Canadian Pacific Railway was settled up by the end of 1914, 2,027 families on 930,000 acres of land. (1)

It was to be expected, the main objective of the early settlers was the growing of wheat crops. The virgin fertility of the soil was conducive to high yields. High prices for wheat encouraged the cultivation of the cash crop principle. More labour was applied and more capital invested in buildings and machinery. In the spirit of the time, little thought was given to the future events from the soil, and conservation was not considered economic. It is quite possible that under the conditions prevailing, exploitation was necessary, because the cost of maintaining the fertility was greater than the value of the increase of resources used in the first particular time.

(1) T. C. Douglas...Prairie Settlement. Vol.1.

With the rain in prices and the bring up of the virgin fertility, the problem of soil blowing were apparent. In the dry areas of the farther it was become obvious that the greatest factor affecting production was rainfall. In the Pocket and Farm Belts, the soils being very reactive to moisture, and rainfall generally being greater, this factor was not of such vital importance. In dry parts of the dry area the exploitive use of virgin fertility had built up unfeeling systems and villages suited to this type of agriculture. Dry years encouraged abandonment of large areas, and it became a problem for the government whether it was cheaper to move the population and return the area to a less intensive type of agriculture with a lower capacity or whether to maintain the present population and try to develop a new type of agriculture more suitable to the conditions which were becoming apparent.

In certain areas, constant cropping under the old system gave rise to an increasing amount of wind erosion in the lighter soils. In the hilly regions water erosion and sheet gully erosion was occurring but its effects were not as obvious. The wind erosion in dry years which gave rise to dust storms of the lighter soil particles were carried along by the prevailing wind, became a menace to a profitable agriculture.

A realization of the changing conditions in Alberta caused the Government in 1930 to appoint a Committee with instructions to "make enquiry to be made into all the conditions presently prevailing in the following districts, namely: that part of the province of Alberta lying to the south of the Red Deer River, to the east of the line between Range 10 and Range 11, west of the Fourth M.e., to the west of the eastern boundary of the province and to the north of the South Saskatchewan River, and, without limiting the generality of the foregoing, to enquire into the possibilities now existing therein, and the lands occupied by farm residents in the said districts; the value of such land and the amounts of mortgages and other charges against the same; the lands in the said districts owned by private persons, and the amount of the mortgages and charges against any such lands; the financial standing of the municipalities, villages and school districts within the said districts; the nature of the land in the said districts, and the use to which the same may be most profitably put; and the measures necessary to bring the said land into such profitable use."(1)

The following year the Committee would hit was created by the Provincial Government on the basis of the recommendations received. These recommendations were for State control

(1) quoted by O. S. Longman...Land Utilization in Alberta. C.S.T.A. Review. December 1933.

of the area in question with a body appointed to administer the lands. It would aim to have control of leases, sales, rentals, inheritances and a greater complete ownership by the Government. A summary of the basic principles of the act are as follows:

"(a) That private ownership will defined areas soil and suitable inhabitants will not provide human subsistence and economic security from ordinary forms based upon current production.

(b) That the recurrence of past experiences be avoided by having lands out of private control and using them part of the public domain, thereby making further settlement and use of the lands subject to administrative control.

(c) That the population residing within the area must be in keeping with its productivity; that dependents of the area to be encouraged to a reasonable degree.

(d) That the method of securing a livelihood within the areas must be designed to the distribution prevailing within the areas, distribution of climate, soil, minerals, and the possibilities of social services, etc.

(e) That to bring about the desired adjustments, a single authority be established to effect the necessary adjustments."(1)

Here we have an example of complete responsibility

(1) Ibid ... .

being taken over by the State for the conservation of land resources and where necessary reclamation. Their object was to conserve the maximum available energy given or remain it as near there as was the best policy. They realised that the soils and their treatment had been a great cause of maladjustment and by taking over control of land use were prepared to attempt to find the most suitable methods for their conservation. Over-grazing of natural pasture was to be discontinued as it is permanent and well-found for grass cover would replace continued exploitation. Some suffering is a result of erosion but it is small part influenced the realization of the need for action.

Since that time more land has been taken under the Special Areas Act, bring the area subject to the Special Areas Act increase approximately 50% to-wards 20,000 square miles or 7,678,720 acres of land.* But only in the land under jurisdiction been increased but the original population of 41,017 on a smaller area has now been reduced to a total of 23,000.(1)

The whole problem is an adjustment of land use such as is being carried on, but the process would have been lengthy and painful because of cost and the general lack of financial resources. The government was prepared to

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* Personal figures from unpublished report on Special Areas, Economics Division, Dominion Department of Agriculture.

(1) Loc. cit...O.S.Longman.

relieve
~~relieve~~ the individual of a great deal of responsibility in the attainment of a profitable use of land.

Problem investigation and action.

The years following 1931 saw a general lowering of the agricultural productivity of the Prairies. Yields were lowered by drought and insect pest. Large areas were cultivated in an attempt to raise grain crops. Soil drifting became a menace and the old order of agriculture on the Prairies seemed to have ended. Individuals were suffering under the unexpected turn of events and the realization that assistance was necessary came before the Canadian Government. It was the government's aim to free the Prairie from rehabilitation help, to provide for the rehabilitation, resettlement and recovery plan of the drought stricken areas of Manitoba, Saskatchewan and Alberta. Plans have been made and the study by specialists of the problems facing agriculture on the Prairies.

Soil surveys for the classification of western soils were carried on in the main that a complete coverage of soil types in Manitoba was obtained for land use. Special attention was paid to the control of drifting soils, as being a community as well as an individual problem. Work included

introduced by a group of farmers near Bowden and Didsbury, Alberta, paved the way for the greater use of an efficient method of soil drifting control. Capital assistance was given to individual farmers from the funds available and under the advice of specialists, the menace of drifting was brought under control. To what extent the EE be should continue financial assistance cannot be said, but the responsibility lies in the hands of the individual farmer, and if control is to continue in such regard control measures or conservation of soil fertility as a part of the costs of production.

An extension of the social conference to community guidance for western problems was introduced. Land control in connection with soil conservation became a specialized study. Plant pathologists took emphasis on the breeding of drought and disease resistant varieties of crops for use on the prairie. The planting of trees was encouraged. Snow boxes and their use in the prevention of soil drifting were taken for this purpose. The addition of natural pasture lands which would control weeds, conserve moisture and prevent soil drifting was recognized as a means towards greater permanency of settlement.

In the southern parts of the western provinces the importance of water conservation has always been realized here and now. Methods to conserve runoff for crop production

suitable use in the control of water and wind erosion. Similarly, some schools have been established. Attention has been drawn to the possibilities of harnessing suitable water in the drier areas by means of irrigation works. This, as a form of resettlement needs study of the potential water resources of the area and their availability for use.

Thus, we see a wide range of personnel requirements and assistance. This can take the form of financial and educational aid. Of particular value is the educational aid. It cannot be expected that the individual should be responsible for the great problems involved in large scale experimental work. These are the tasks which the nation must bear in the process of raising ability. A great deal of human discomfort and suffering can be eliminated by the application of scientific knowledge to the tasks of planned resettlement. With regard to this study which follows this may prevent interpretation, and thus cover the ends in any future resettlement which may be planned hereafter.

Also the broad needs of resettlement begun by the government, if this benefit the individual by raising their improvements. This would apply to all areas where agriculture is practised. Assistance financial aid over a long period of time in the process of resettlement might indicate re-

ortivity. Plant breed can also do much to evolve the cultivar to suit in a profitable way to himself and his community. By placing the results of experimental work before him he will be able to answer his problems accordingly, if he is to be advised. Considerable erosion and ignorance will be overcome and assist in the continuous process of finding the most economic use for any land.

Much work has been done in Canada on wind erosion control and the value of various cropping practices in the retention of soil fertility. The problem of soil conservation, however, is far from solved. There will depletion over extensive areas so as the landowner always find it profitable to keep his land constantly under some kind of crop.

A step in this direction might be a classification of land on a physical basis of productivity correlated with economic and social factors. In this connection the productive capabilities of areas and soil types could be given by means of maps indicating the types of climatic and cropping problems, suitable for each area. In order E. A. Norton in this connection - "a land classification must provide a basis for the most intensive use consistent with preservation of the land itself as a productive entity". (1) Consequently a present use of land under the prevailing methods of agricultural

(1) E. A. Norton...University of Missouri. College of Agriculture. Bulletin 421. p.32.

technique, with the opinions of local farmers and inhabitants, he then suggests the following broad division of Lands with the object of erosion control.

"(a) Lands suitable for cultivation.

(b) Lands not suitable for cultivation, but suitable for permanent vegetation with grazing or woodland use.

(c) Lands not suitable for productive vegetation." (1)

So that classification can then be correlated the economic and social factors involved. Of necessity there are limitations to the accuracy of such a classification, but as Professor Bunce says in discussing the question "They may be of great value in indicating that if we continue over a certain land use pattern, we will deplete or build up our land assets, and that this factor must be considered when the economic aspects of the system are being evaluated. In other words, the classes may act as standards to indicate whether we are removing or increasing our productive capital in land and to what they will be extremely valuable in farm planning as a whole if their limitations are kept in mind." (2)

A similar cause for the existence of soil depletion may be found in the Western problem. A study portraying to the public, erosion, declines and land use will assure any

(1) Loc. Cit...p.284.
(2) Ibid...p.315. A. C. Bunce.

throw further light on the whole land ownership is necessary before the individual will interest himself in conservation practices. It is general, that more need be the case than is would be of interest to the landowners and the government to further investigate the tenure situation, to aim at the alleviation of lack of interest in the land as an investment, and to create incentive for security tie.

Many problems of conservation are local in nature and more possible technical advice should be given to individuals. Much could be done by educational and extension programs pointing out the profits to be gained from conservation as against the losses from exploitation, when exploitation is responsible for the individual and the community. Could one of the greatest causes of fertility depletion, and as Gilbert pointed out in 1934 "growing wheat for several years in succession, with subsistent cultivation, lumbering of woods, and burning of stubble, and generally the mining of the reserve of the rooting depth - only one yields can be expected". (1) Everyone practice control of weeds or insect pests and rotations can do much to alleviate unnecessary fertility depletion.

The land use pattern of Canada may be expected to change with the scientific and technological advances

(1) Dr J. H. Gilbert...Agricultural Investigations at Saskatoon, Sask. D.S.T.R.Bulletin. 171.

the country. The level of economic exchange has also changed, and more control over the sale of commodities exists so that much capital will be maintained by the university body, for the continuation of profitable operations in future years.

PART V.

CONCLUSION.

"There is no evidence of a general soil exhaustion and decline in productivity except as men have failed as husbandmen".(1)

Studies have been made of the relationship between man and the soil. Past history affords us examples from which we may make certain assumptions. The rise and fall of Empires has been traced to the lack of stability in soil fertility. Could it not be equally true that the productivity of the land decreased because of its treatment by man? Except for inundation or severe depopulation by wars, there is no proof but land seems to be able to produce now what it did a hundred years ago. It may be that because of a change in social ideas or implements a sudden keen interest in the land, as a major problem, spurts. Isolation can be observed by research or battle and have productive potential. A decline in the economic stability of the nation may cause it the same loss as a decline in soil fertility. The two cannot be stated as cause and effect, however, even though direct dependence might imply this. The soil has determined in production because man has failed to use all the means at his disposal to encourage this production.

(1) Charles E. Kellogg...Soil and Society. Yearbook of Agriculture. United States Department of Agriculture 1938. p.876.

Therefore, when we speak of soil exhaustion and loss of fertility we must not accept this solely as a natural process. Rather must we look into the manner through the association of man with the soil. The limits of the productivity of soil under the specialized use of man are not easily specified. Artificial means of stimulating such production have far from reached their peak, and the possibilities for future development in this direction must result in more conjecture. The productivity of soils must at best be considered as limited. Intensive and improved transportation, and the growth of rural population may affect the intensity of land use in the future, so that some modification of conservation would be necessary.

There is both "good" and "bad" use of land. By "good" use is meant that the land is used in such a way as to obtain the maximum of satisfaction for the individual and society over time. To obtain this may require the sacrifice of one resource primarily to conserve it in the building up of another. The whole field of productive capacity of the land is explored so that a stabilized level of production is reached and maintained, which will give the greatest returns under the prevailing conditions. This is practically a self-imposed control.

"Bad" use is the converse of this. That is any use

maximum which the greatest possible returns from land are not attained and maintained under conditions of that time. The attainment of such productivity is not sufficient or itself to be described as "good" use. The question of sustainable land use into sustainable, and any such state which cannot be maintained without detriment to the physical factors of the soil cannot be termed "good". On the other hand prevailing conditions may have the effect of classifying the land at a lower grade than is set its physical status, but which cannot be considered "bad" use at the time.

The social and economic conditions affecting land use are numerous. Some of these have been mentioned, such as tenure, land ownership, value, taxation and the individual's attitude towards the land. The process of putting these effects must of necessity take time. There will be an adjustment of economic and social conditions be said to be used in question. Man will adjust his techniques as new conditions arise. The government and the individual must work together, but if an evaluation is made toward the state of "good" land use now, the existing conditions cannot be said to encourage profitable returns from the land either for the individual or the country in question. It would be necessary at the long time demand for products from the soil from to any condition under

with the productivity of the soil is decreasing, some-
example reasons must be found, if the cotton is to progress.

Careless use of land may have permanent effects
and leave the results obvious to the eye. In the case of
loss of fertility may not always be so obvious. In highly
fertile soil, fertility depletion may not be noticed since
production is maintained. Where the physical results are
obvious, as in erosion, present action may prevent further
deterioration and assist the cause of future restoration.
However, a more detailed study would be necessary to indicate
where fertility depletion was occurring, and whether its cause
was to be found in cropping practices. The introduction of
suitable rotations and combinations of the cropping system
with improved live stock may have considerable effect on the
retention of fertility on a permanent level.

It has been the object of this discussion on con-
servation, more to indicate the possibility of soil depletion
in Sudan cotton, than to make a definite statement as to
existence or non-existence in a particular area. From some
of the examples given and a more detailed study of certain
areas, the reader will be able to draw his own conclusions
on the matter.

We must admit that where population is sparse and relatively large tracts of land are farmed by an individual, there is a more decisive use of the soil resources than where farming is intensive. But it would be very unlikely for the farmers to do otherwise under the prevailing conditions, as we are not prepared to argue without more conclusive evidence.

However, if the population of Western Canada increases in the future, the effect of greater local needs might seem more intensive type operations. The scarcity value of land by purpose, and land which is now considered unsuitable for cultivation brought into use. Farm products which are now considered satisfactory under the prevailing conditions of prices, may become much more difficult to satisfactory in the future.

It is true that the concern is an extreme possibility, but is just conceivable one may envisage changes in the economic organization of a country as a whole. We must also agree that maximum use of resources of a country should be obtained. This would well apply to land in terms of agricultural production.

Therefore if the future of Canada's resources are to concern us to-day, more concern must attach to the use of farm land. The question then naturally arises as to where

the aims of this concern rests. Each individual comprising the nation is primarily interested in his own welfare. Under our democratic form of government, the interests of a community are expressed through an individual who takes his place in that government. Then gathered together in parliament these individuals should represent the sum total of the major national interests of the country. Whilst they are in office, the policies which affect the welfare of the country are their responsibility and it would seem logical to presume that the effect of such policies on the future welfare of the country is also their responsibility.

Therefore, by this line of reasoning the present use of land, as it affects the future of that land, and which is reflected to a great extent by the national and international policies instigated by the government, should be their concern. By being representatives of the nation they cannot be expected to have greater foresight than the individuals comprising that nation. The point is, however, that the nation, in having the responsibility of being foresight in the future development of the country, on their shoulders, expects them to act accordingly. If then, in the formation of national land policies we care to speak of 'social time preference' and 'individual time preference' we should not speak of the two as being different spheres of thought, but rather as one being the fraction of the other.

If the future welfare of a country is of interest to anyone, it should be of interest to the government which bears the responsibility of the individuals' interests. Therefore, with this responsibility in mind, they can rightfully interfere with the present economic use of land because of future national welfare.

The use of land depends on the social and economic framework of society. A change in one must necessitate a change in the other. A close association of the two is inevitable for the future welfare of a group or nation and the maintenance of a stable agriculture.

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